

A NEW NORTH AMERICAN SPECIES IN THE *SIMULIUM*  
*VERNUM* GROUP (DIPTERA: SIMULIIDAE) AND  
ANALYSIS OF ITS POLYTENE CHROMOSOMES

PETER H. ADLER

Department of Entomology, Clemson University, Clemson, South Carolina 29634.

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**Abstract.**—*Simulium loerchae* Adler, new species, a North American member of the *Simulium vernum* group, is described from South Carolina, Pennsylvania, and Tennessee. Larvae, pupae, males, females, the polytene chromosomes, and the habitat are described. The species is chromosomally monomorphic and can be derived from the standard sequence of *S. vernum* by three fixed inversions. Affinities with North American and European *vernum* group members are given.

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The *Simulium vernum* Macquart group in North America consists of eleven described species, nearly all of which are primarily northern in distribution. The group is characterized by the triangular flange of the male gonostylus. Taxonomic and chromosomal treatments of the group members were given by Stone and DeFoliart (1959), Davies et al. (1962), Brockhouse (1985), Hunter and Connolly (1986), and Adler and Currie (1986). Immatures of most species inhabit small, cool, woodland streams, and the adults are principally ornithophilic.

I describe all life stages and the polytene chromosomes of yet another new species in the *S. vernum* group. Larval descriptions are based on material preserved in Carnoy's fixative (1 part glacial acetic acid : 3 parts absolute ethanol). Pupal descriptions are based on specimens in Carnoy's fixative and exuviae in glycerin. Measurements of adults are taken from freshly pinned material; colors are those of dried specimens. Life-stage descriptions follow the format and terminology used by Adler and Currie (1986). Chromosomes were prepared by the Feulgen technique (Rothfels and Dunbar 1953), and both temporary and permanent mounts (in Euparal®) were examined under oil im-

mersion (1250×). The chromosomal complement is described relative to the *vernum* standard (Knebworth cytotype) sequence of Brockhouse (1985). Fixed inversions are italicized and numbered in order of their discovery (within an arm), beginning after the last numbered inversion of Hunter and Connolly (1986).

All material in Carnoy's fixative was transferred to 80% ethanol for permanent storage. The holotype and some paratypes are deposited in the United States National Museum of Natural History, Washington, D.C. Additional paratypes are deposited in the Canadian National Collection, Biosystematics Research Centre, Ottawa; the British Museum (Natural History), London; the Clemson Entomological Museum, South Carolina; and the Frost Entomological Museum, Pennsylvania State University. Photographic negatives and contact sheets accompany paratypic chromosome preparations.

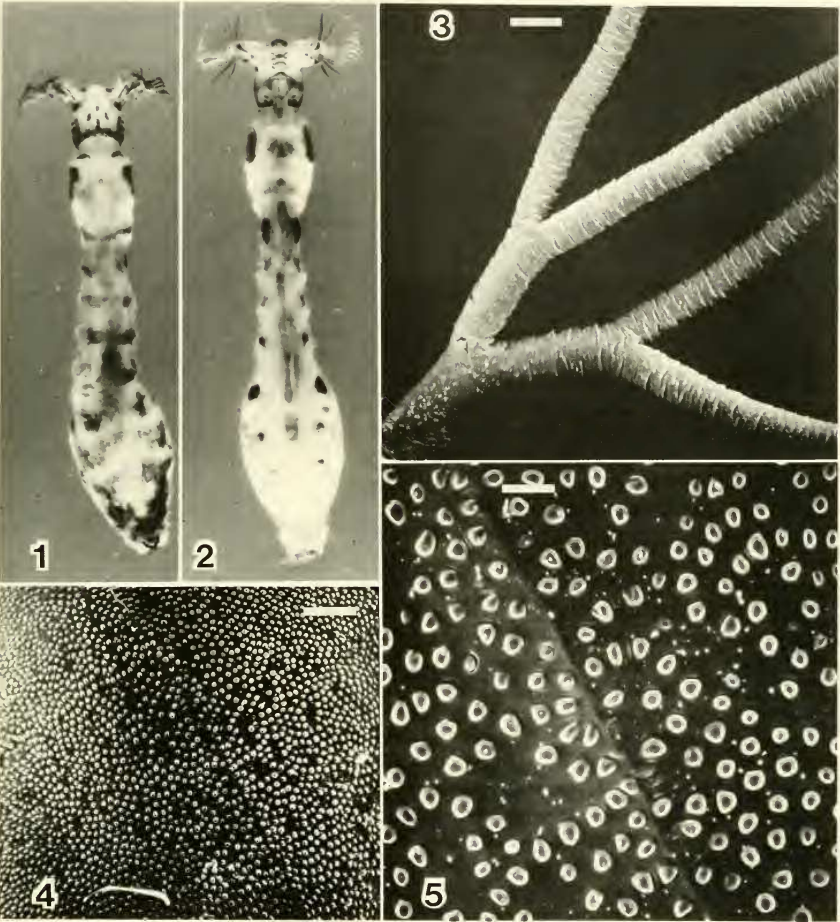
*Simulium loerchae* Adler,  
NEW SPECIES  
Figs. 1-13

Larva (final instar).—Length 5.4-6.7 mm ( $\bar{x}$  = 6.0 mm). Head capsule (Fig. 6) rather

uniformly pale yellowish brown; headspots brown, distinct, occasionally surrounded by infuscation posteriorly (as in Fig. 1); eye spots rather large; line over eye spots thin, brown. Antenna with distal article brown, median article translucent or brown dorsally, proximal article brown dorsally, translucent ventrally or entirely translucent; apex of median article not reaching end of labral-fan stalk; proportions of articles (distal to proximal) 1.1:1.0:1.0. Labral fan with 37–51 ( $\bar{x}$  = 45) primary rays in South Carolina specimens [50–54 ( $\bar{x}$  = 52) in Tennessee specimens; 48–55 ( $\bar{x}$  = 52) in Pennsylvania specimens]. Hypostomal teeth (Fig. 8) with median tooth and lateral teeth relatively large and subequal in length and prominence; sublateral teeth variously smaller, with outermost or innermost sublateral teeth longest and median sublateral teeth shortest; lateral margin of hypostoma with 0–2 paralaral teeth and 3–5 lateral serrations per side; hypostoma with 3–4 prominent and 1–2 small lateral setae per side. Postgenal cleft (Fig. 7) about 1.5 times as long as wide, extending about  $\frac{2}{3}$  distance to hypostomal groove, widest at midpoint, rounded apically; subesophageal ganglion lightly pigmented. Maxillary palpus 4.0–4.4 times as long as basal width. Inner subapical ridge of mandible with 2–4 small teeth basal to 1 large, subtriangular tooth. Lateral plate of thoracic proleg moderately sclerotized, elongate, extending almost entire length of apical article. Body (Figs. 1, 2) reddish; pigmentation heaviest dorsally on segment 8 and dorsolaterally on segments 6–7; segment 5, and sometimes 1, with a single conspicuous, reddish pigment spot per side; intersegmental bands clear, distinct; ventral tubercles conspicuous, about  $\frac{1}{3}$  depth of abdomen at attachment points; posterior 4 abdominal segments dorsally with widely scattered, short, yellowish brown, simple setae. Anterodorsal arms of anal sclerite broadly connected to and subequal in length to or slightly shorter than posteroventral arms. Rectal setulae present between and at apices

of anterodorsal arms of anal sclerite. Posterior proleg bearing 7–12 hooks in 65–68 rows. Anal papillae of 3 compound lobes.

Pupa.—Length 2.6–3.2 mm. ( $\bar{x}$  = 2.9 mm). Head projecting downward, with many minute granules as on thorax; antennal sheath of female extending slightly beyond posterior margin of head; antennal sheath of male extending about  $\frac{1}{2}$  distance to posterior margin of head. Gill (Fig. 3) about 0.4 mm longer than pupa, consisting of 4 filaments; base short, giving rise to 2 petioles that diverge vertically at an angle of 46–73° ( $\bar{x}$  = 58°); ventral petiole up to twice as long as, subequal in thickness to, and (in dorsal view) subparallel to dorsal petiole; ventral petiole giving rise to 2 filaments bifurcating in horizontal plane; dorsal petiole giving rise to 2 filaments bifurcating in vertical plane (plane of bifurcation variable for filaments of both petioles in Pennsylvania specimens); filaments long, thin, tapering, with numerous ridges and shallow furrows; surface sculpturing of base weakly differentiated. Thorax with abundant, closely set, uniformly spaced, minute, rounded granules (Figs. 4, 5); trichomes simple, long, very slender, pale, 7 or 8 on each side of thorax. Tergite I with 1 pair of setae; tergite II with 5–7 anteriorly directed setae on each side of midline, and 1–2 minute setae laterally; tergites III and IV each with 4 anteriorly directed hooks on posterior margin on either side of midline, 1 small seta between and anterior to 2 outermost hooks, and 1–2 small setae laterally; tergites V to VIII each with row of fine, posteriorly directed spines along anterior margin on either side of midline (spines of tergite V often numbering 0–1 per side); tergite IX with pair of very short, stout, slightly curving, dorsally directed terminal spines. Pleural membrane of segments II to VII usually with at least 1 minute seta per side. Sternite III with pair of minute setae anteriorly and 2 pairs of minute setae posteriorly; sternite IV posteriorly with 2 pairs of heavy, simple or bifid, anteriorly directed setae and at least



Figs. 1-5. *Simulium loerchae*. Figs. 1, 2. Larval habitus. 1, Dorsal view. 2, Ventral view. Figs. 3-5. Pupa (scanning electron micrographs). 3, Gill (lateral view), scale bar represents 50  $\mu\text{m}$ . 4, Thorax (dorsal view), scale bar represents 38  $\mu\text{m}$ . 5, Granules on portion of thorax (dorsal view), scale bar represents 10  $\mu\text{m}$ .

2 pairs of fine setae; sternite V posteriorly with 2 pairs of closely set, anteriorly directed, bifid or trifid, hook-like setae and at least 1 pair of fine setae; sternites VI and VII posteriorly with 2 pairs of distantly set, bifid to quadrifid, hook-like setae, and at

least 1 pair of fine setae; sternites VIII and IX with at most 1 pair of fine setae; sternites III to VIII with numerous tiny rows of extremely fine microspines. Cocoon well formed, with anterodorsal projection broad and accounting for about 16.9-26.5% ( $\bar{x}$  =

22.2%) total cocoon length (in lateral view); anterior margin and anterodorsal projection reinforced.

Female.—Generally brown with gray pruinosity and pale golden pile (some specimens with pile more silvery). Length: body, 2.7–3.0 mm ( $\bar{x}$  = 2.8 mm); wing, 2.7–3.1 mm ( $\bar{x}$  = 2.9 mm).

Frons at vertex about 2 times broader than at narrowest point, slightly less than  $\frac{1}{4}$  width of head, with decumbent, pale golden pile laterally. Clypeus slightly longer than wide, with sparse, pale golden pile. Occiput with long, pale golden pile reaching posterior margin of eye; postocular setae black. Antenna with fine silver pubescence; first flagellomere longest; pedicel and scape brown to light brown; flagellum dark brown. Mandible with 38–40 serrations. Lacinia with 23 retrorse teeth. Palpus dark brown, with stout, golden setae; palpomere V 1.3–1.6 times as long as III. Sensory vesicle located subcentrally, occupying  $\frac{1}{2}$  to  $\frac{3}{4}$  of palpomere III; neck long, thin, arising near anterodorsal margin, opening to exterior through rounded, slightly expanded mouth. Median proximal space of cibarium U-shaped.

Postpronotum dark brown; pile long, erect, pale golden. Scutum dark brown, humeral angle brown; pile recumbent, pale golden. Scutellum brown, with long, pale golden pile mixed with black setae. Postnotum brownish black. Anepisternum and katepisternum dark brown; membrane and mesepimeron lighter brown; mesepimeral tuft of long, golden setae. Wing veins pale yellowish brown. Setae on stem vein and costal base dark brown with golden reflections; setae on other veins primarily brown; subcosta setose ventrally; fringe of calypter and alar lobe pale golden. Halter tan, with line of golden pile. Coxae, tarsi, and apices of femora and tibiae primarily brown, remainder of legs light brown; pile on coxae pale golden, golden on femora and tibiae, primarily brown on tarsi; hind basitarsus

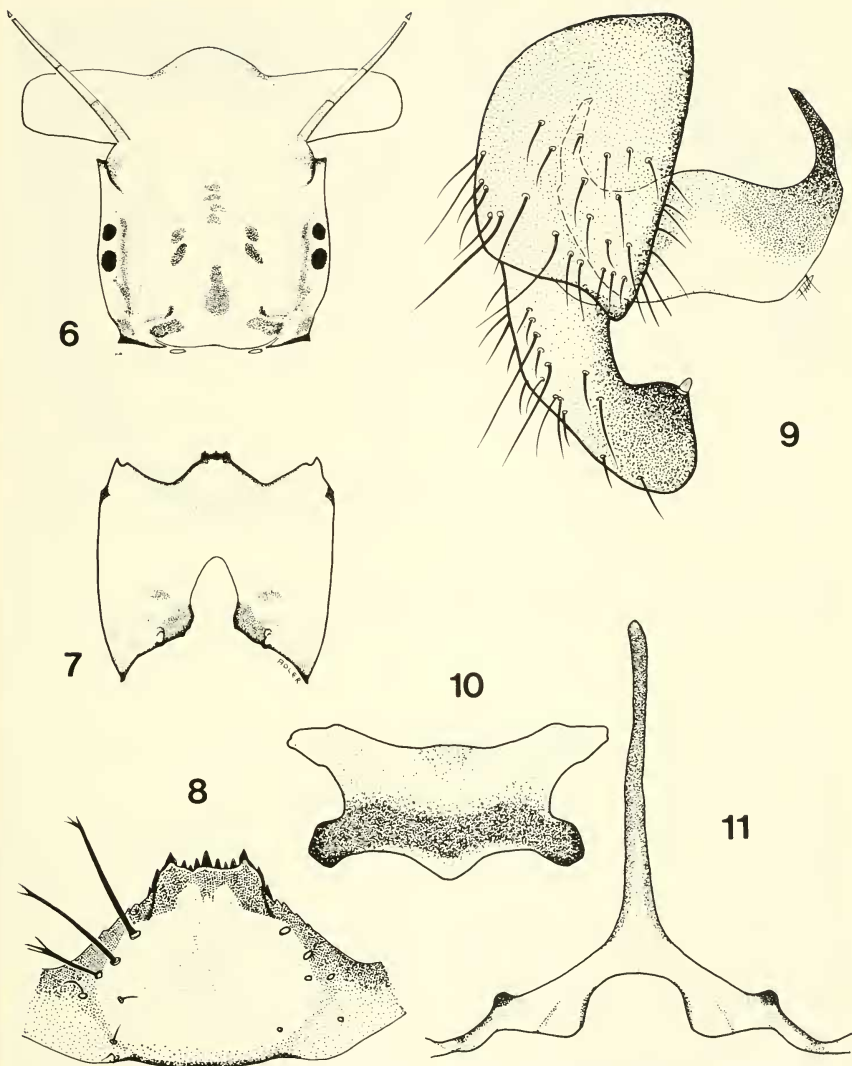
6.5–6.7 times as long as broad; calcipala and pedisulcus well developed; claws each with large, basal, thumb-like lobe.

Abdominal sclerites brown; pile sparse, pale golden; additional sparse, long, black setae on tergites VIII–IX; membranous areas gray to tan, with sparse, mixed black and pale golden pile. Basal fringe of very long, pale golden pile. Anal lobe subtriangular to subquadrate in lateral view, with acute posterodorsal extension, and small, anteroventral nipple. Cercus subrectangular, about twice as broad as long, posterior margin straight, corners well rounded. Hypogynial lobe subtriangular, somewhat acute posteriorly, space between lobes rather wide. Genital fork (Fig. 11) with stem moderately long and slender; lateral arms rather broad basally, forming subquadrangular space in region of bifurcation, posteromedial areas well developed and with bluntly squared angles. Spermatheca of moderate size, longer than broad, with surficial pattern of subequal polygons.

Male.—Generally velvety black with gray pruinosity and golden-brown pile. Length: body 2.5–3.0 mm ( $\bar{x}$  = 2.7 mm); wing, 2.3–2.6 mm ( $\bar{x}$  = 2.5 mm).

Frons and clypeus with erect, brown pile. Occiput with long, erect, brown pile. Antenna dark brown, with fine, light brown pile; scape and pedicel paler. Palpus dark brown, with brown pile; palpomere V about twice as long as palpomere III. Sensory vesicle subspherical, about  $\frac{1}{5}$  length of its segment; neck long, slender, opening to exterior through rounded mouth.

Postpronotum brown, with golden pile. Scutum black, with recumbent, golden pile. Scutellum brown, with brown or mixed gold and brown pile. Postnotum brownish black. Anepisternum dark brown, lighter posteriorly; katepisternum blackish brown; membrane and mesepimeron brown; mesepimeral tuft of long, mixed golden-brown and brown pile. Wing veins pale yellowish brown. Setae on stem vein and costal base



Figs. 6-11. *Simulium loerchae*. Figs. 6-8. Larva. 6, Head capsule (dorsal view). 7, Head capsule (ventral view). 8, Hypostoma (ventral view). Figs. 9, 10. Male. 9, Terminalia (ventral view with left gonocoxite and gonostylus removed). 10, Dorsal plate (dorsal view). Fig. 11. Female genital fork.

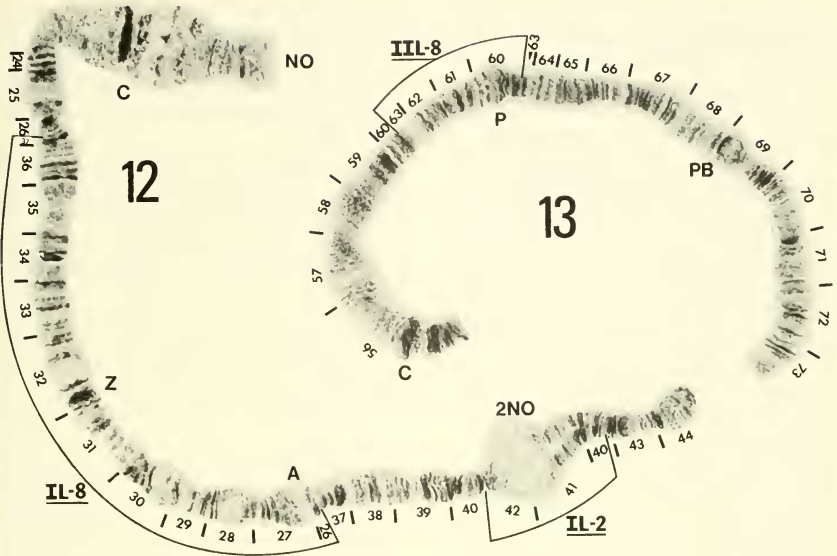
brown; setae on other veins brown to golden brown; fringe of calypter and alar lobe golden to golden brown. Halter tan to gray, with darker edging and golden-brown pile. Legs dark brown; midsection of femora and tibiae and base of basitarsi brown to light brown; pile golden to brown. Hind basitarsus 4.1–4.6 times as long as broad.

Abdominal tergites dark brown, with golden-brown pile; membranous areas grayish, with long, golden-brown setae laterally on segments III and IV; sternites brown, with long, brown pile. Basal fringe of very long, brown to golden-brown pile. Terminalia as in Fig. 9. Gonocoxite about 1.5 times longer than broad. Gonostylus about as long as gonocoxite, about 2.5–3.0 times as long as breadth at midpoint, expanded apically into flattened, subtriangular, medially directed flange bearing 1 apical spine. Ventral plate in ventral view subrectangular, about 2 times as broad as long, tapering posteriorly, with posterolateral corners well rounded and posterior margin slightly concave; anterior margin slightly convex; arms strongly bowed, with tips curving inward; lip in terminal view pronounced, broadly rounded; stem of median sclerite long, slender, forked about  $\frac{1}{4}$ – $\frac{1}{2}$  distance from distal end; dorsal plate (Fig. 10) large, well sclerotized, subrectangular, with short projections at each corner and rounded protuberance distally; paramere in lateral view moderately narrow basally, broadening medially and bearing 1 long, slender, strongly sclerotized spine-like process.

Chromosomes (from larval salivary glands, 44 preparations examined).— $n = 3$ ; chromocenter absent; B chromosomes lacking; chromosome I with expanded centromere region; IS standard for *vernium* sequence; IL (Fig. 12) with inversions *IL-2* of Hunter and Connolly (1986) (limits 40B4–42C1 inclusive) and *IL-8* (limits 26C2–37A2 inclusive), and with secondary nucleolar organizer expressed in section 41C–42B; IIS standard for *vernium* sequence; IIL

(Fig. 13) with inversion *IIL-8* (limits 60B–63B inclusive); IIIS and IIIL standard for *vernium* sequence; sex chromosomes undifferentiated; floating inversions lacking.

Types.—Holotype: ♂ with exuviae, tributary of Indian Creek, 1.0 km from entrance of Clemson University Experimental Forest, Pickens County, South Carolina (34°44'40"N × 82°50'51"W), 22-II-86, collected by C. R. L. Adler. Allotype: ♀ with exuviae, same data as holotype, 22-II-86, collected by C. R. L. Adler. Paratypes: SOUTH CAROLINA: PICKENS COUNTY: unnamed spring-fed stream, Willow Wood subdivision, 5.5 km NE of center of Clemson University campus (34°42'25"N × 82°47'22"W), 17-XI-85, 5 larvae, C. R. L. Adler; 11-I-86, 17 larvae, 2 chromosome preparations (♂ larvae), 1 ♂ with exuviae, 1 ♀ with exuviae, C. R. L. and P. H. Adler; 19-I-86, 3 larvae, 2 pupae, 1 pupal exuviae, 1 ♀ with exuviae, C. R. L. and P. H. Adler; 25-I-86, 31 larvae, 3 pupae, 1 ♀ with exuviae, C. R. L. and P. H. Adler; 2-II-86, 15 larvae, 6 chromosome preparations (5 ♂ larvae, 1 ♀ larva), 3 ♂♂ with exuviae, 1 ♀ with exuviae, C. R. L. and P. H. Adler; 16-II-86, 14 larvae, 8 chromosome preparations (2 ♂ larvae, 6 ♀ larvae) with photographic negatives and contact sheet, 3 ♂♂ with exuviae, 3 ♀♀ with exuviae, C. R. L. and P. H. Adler; 2-III-86, 2 ♂♂ with exuviae, 1 ♀ with exuviae, C. R. L. and P. H. Adler; 16-III-86, 1 larva, 2 ♂♂ with exuviae, C. R. L. and P. H. Adler; 19-X-86, 4 larvae, C. R. L. and P. H. Adler; Indian Creek, 0.5 km from entrance of Clemson University Experimental Forest, 22-II-86, 7 larvae, C. R. L. and P. H. Adler; 19-XII-86, 7 larvae, 1 chromosome preparation (♀ larva), C. R. L. Adler; 6-I-87, 16 larvae, 3 chromosome preparations (♀ larvae), 2 pupae, C. R. L. Adler; tributary of Indian Creek, 1.0 km from entrance of Clemson University Experimental Forest, 22-II-86, 3 larvae, 1 chromosome preparation (♂ larva), 1 pupa, C. R. L. and P. H. Adler; first stream past



Figs. 12, 13. *Simulium loerchae*, chromosomes of larvae from Pennsylvania (18 June 1986). 12, IL sequence with fixed inversion limits indicated by brackets, A = apolar diffuse group, C = centromere, NO = nucleolar organizer, 2NO = secondary nucleolar organizer, Z = 'Z' marker. 13, IIL sequence with fixed inversion limits indicated by bracket, P = DNA puff, PB = parabalbani.

Willow Spring, 2.2 km from entrance of Clemson University Experimental Forest, 22-II-86, 1 larva, C. R. L. Adler; second entrance to Dalton Road, 2.6 km from entrance of Clemson University Experimental Forest, 22-II-86, 2 larvae, C. R. L. Adler; Hemlock Picnic Area, Table Rock State Park, 11-V-86, 84 larvae, 11 chromosome preparations (5 ♂ larvae, 6 ♀ larvae) with photographic negatives and contact sheet, 2 ♂♂ with exuviae, 1 ♀ with exuviae, P. H. Adler; 21-III-87, 12 larvae, 5 pupae, 2 pupal exuviae, C. R. L. and P. H. Adler; White Oaks Picnic Area, Table Rock State Park, 18-V-86, 1 larva, P. H. Adler; OCONEE COUNTY: tributary of Chauga River, county road TU-37, 4-II-86, 3 larvae, 1 pupal exuviae, C. R. L. Adler; ANDERSON COUNTY: W tributary of Watermelon

Creek, 0.4 km N of S-4-148, 11-XII-80, 5 larvae, J. S. Weaver and E. R. Taylor; 18-V-79, 1 larva, J. S. Weaver and E. R. Taylor; W tributary of Watermelon Creek, S of S-4-63, 26-III-81, 1 larva, J. S. Weaver and E. R. Taylor; 15-XII-80, 2 larvae, J. S. Weaver and E. R. Taylor; Watermelon Creek, 0.6 km N of S-4-63, 3-IV-80, 1 larva, J. S. Weaver and E. R. Taylor; Browns Creek (E Rock Creek), 0.4 km N of S-4-147, 14-III-79, 1 larva, J. S. Weaver and E. R. Taylor; E tributary of Rock Creek, N of S-4-670, 27-XI-80, 1 larva, J. S. Weaver and E. R. Taylor; jct. Rt. 412, W of Starr, 1.0 km E of Rt. 187, 8-II-87, 1 larva, 1 chromosome preparation (♀ larva), P. H. Adler; Tanglewood Spring, Pendleton, 9-II-87, 3 larvae, M. W. Heyn and C. Watson; PENNSYLVANIA: CENTRE COUNTY: Sand Spring,

Shingletown Gap on Tussey Mountain, ca. 5 km SSE of State College, 31-V-86, 5 larvae, 2 chromosome preparations (1 ♂ larva, 1 ♀ larva) with photographic negatives and contact sheet, 1 pupa, S. Tessler; 18-VI-86, 11 larvae, 5 chromosome preparations (3 ♂ larvae, 2 ♀ larvae) with photographic negatives and contact sheets, S. Tessler; 16-IX-86, 20 larvae, 2 chromosome preparations (♀ larvae) with photographic negatives and contact sheet, 4 pupae (1 with pharate ♂), S. Tessler; TENNESSEE: SULLIVAN COUNTY: East Inlet Creek, Bays Mt. Park, near Kingsport, 28-II-87, 3 larvae, 2 chromosome preparations (♂ larvae), C. Watson; 15-III-87, 8 larvae, C. Watson.

Additional specimens examined.—PENNSYLVANIA: CARBON COUNTY: Hickory Run State Park, 12-V-87, P. H. Adler, 3 larvae (third–fourth instars).

Etymology.—This species is named in honor of my wife, Cynthia R. Loerch Adler, whose many collections of simuliids over the years resulted in discovery of the type locality. She subsequently collected and reared many of the specimens in the type series.

Biology.—*Simulium loerchae* has been collected from the mountains of central Pennsylvania and eastern Tennessee and the mountains, foothills, and upper piedmont of South Carolina. In South Carolina, immatures were collected from October to mid-May in permanent and temporary, sandy-bottomed, woodland streams less than a meter in width and ranging in temperature from 6.5° to 17°C ( $\bar{x}$  = 12°C,  $n$  = 24). Stream conductivity averaged  $22.7 \pm 10.4$   $\mu$ S (standard deviation) and pH averaged  $6.86 \pm 0.30$  ( $n$  = 7). Pupae were found as early as January; adults emerged from these pupae within 24 h at room temperature. Larvae and pupae were collected most frequently from fallen leaves. Pupae were often obscured by sediment covering the leaves. Immatures were collected with those of *S. tuberosum* Lundström cytospecies FGH at all 1985–1986 sites, with *Prosimulium mix-*

*tum* Syme & Davies at half of the sites, with *S. tuberosum* cytospecies A at two of the sites, and once with *S. impar* Davies, Peterson, & Wood. One larva was infected with the fungus *Coelomycidium simulii* Debaisieux.

In Pennsylvania, *S. loerchae* is apparently bivoltine. Immatures were collected in Centre County from a permanent, sandy-bottomed, woodland stream ranging in temperature from 9° to 15.5°C and not more than 0.5 m in width. Larval substrates included leaves, pebbles, and detritus. Pupation occurred on pebbles and on both sides of fallen leaves. Immatures were collected with those of *P. fontanum* Syme & Davies, *S. gouldingi* Stone, and *S. venustum* Say cytospecies CC.

In Tennessee, larvae were collected from fallen leaves in a permanent stream approximately 1.0 m wide, up to 30 cm deep, and with a temperature of 9.5°C. Associated simuliids included *Stegopterna mutata* (Malloch) triploid cytospecies and *Prosimulium rhizophorum* Stone & Jamnback.

Females emerged with immature eggs and little stored nutrient. Ornithophily is inferred from the well-developed mouthparts and bifid claws.

Remarks.—The pupa and female of *S. loerchae* are very similar to those of *S. caledonense* Adler and Currie. The pupa of *S. loerchae* may be differentiated by the abundance of closely and uniformly set granules on the head and thorax. The female may be distinguished with difficulty from that of *S. caledonense* by the wider space between the hypognathal valves and the shape of the genital fork. The larva may be identified principally by the color and distribution of abdominal pigment and the shape of the postgenal cleft. The large, subrectangular dorsal plate of the male is unique.

Chromosomally, *S. loerchae* is monomorphic, possessing a primitive  $X_0Y_0$  sex-chromosome system and lacking autosomal rearrangements. It can be derived from the *vernum* standard by three inversions, and

can be recognized most easily by the DNA-puff inversion (limits 60B-63B). *Simulium loerchae* shares the fixed inversion *IL-2* with North American *S. gouldingi*, *S. croxtoni* Nicholson & Mickel, and *S. sp.* of Hunter and Connolly (1986), as well as with European *S. carpathicum* Knoz and *S. cryophilum* Rubzov. Inversion *IL-8*, which re-orientes the 'Z' marker and places the apolar diffuse group 26C2-27A (inclusive) in the distal half of *IL*, and inversion *IIL-8* are both autapomorphic.

#### ACKNOWLEDGMENTS

I thank Fiona Hunter (University of Toronto) for critically reviewing the cytological section, J. C. Morse (Clemson University) for reviewing the manuscript, J. R. Brushwein (Clemson University) for photographing the larva, S. Tessler (Pennsylvania State University) for providing Pennsylvania specimens and accompanying biological information, and C. Watson (Clemson University) for providing Tennessee material and information. Technical

Contribution No. 2734 of the South Carolina Agricultural Experiment Station, Clemson University.

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